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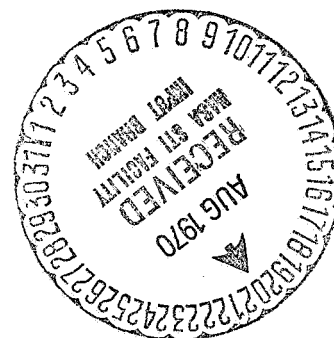
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**SUBJECT:** Geologic Characteristics of Lade, a  
Possible Apollo Highland Landing Site  
Case 340

**DATE:** July 24, 1970**FROM:** J. W. Head**ABSTRACT**

Several of the highland sites have been deleted from consideration as potential Apollo landing sites and several others require additional photography before landings can be committed. Realization of the possibility that a lower priority highland site covered by sufficient photography might need to be evaluated for a highland landing mission led to reconsideration of a site near the crater Lade.

The Lade area is located approximately 1°S and 14°E and is covered by Lunar Orbiter III medium and high resolution photography. The area lies in a highland terrain and is characterized by the presence of broad lineations radial to the Imbrium basin. Since extensive outcrop and discrete geologic boundaries are lacking at this site, a sampling of "typical" terra is probably the most logical scientific objective for a possible mission to this site. Exclusion of several other highland sites from consideration for landing missions and more detailed study of the Lade geology are two factors which might raise the priority of a landing mission to Lade.



(NASA-CR-109970) GEOLOGIC CHARACTERISTICS  
OF LADE, A POSSIBLE APOLLO HIGHLAND LANDING  
SITE (Bellcomm, Inc.) 11 p

N79-73410

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FF No. 60	CX-104410	13
	(NASA CR OR TMX OR AD NUMBER)	(CATEGORY)

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### MEMORANDUM FOR FILE

#### Introduction

Since some of the highland sites have been deleted from consideration as potential Apollo landing sites (Tycho, Censorinus) and several others require additional photography before landings can be committed (Descartes, Davy), it is possible that a highland landing will have to be made at an alternate scientific site which is covered in sufficient detail by existing photography. Consideration of this possibility resulted in the reconsideration of a site near the crater Lade. The purpose of this memorandum is to outline the geological characteristics of this site. These should form the basis for any future discussion of Lade.

#### Location and Characteristics

The Lade area is located approximately 1°S and 14°E, about 500 km northwest of Theophilus, 350 km northeast of Hipparchus and approximately 320 km north of the crater Descartes. This area lies in the region of the moon about 85 km east of Lade and in the vicinity of Theon Junior B (Figure 1).

This region was photographed by Lunar Orbiter III and was designated as Site III-S-10. The location of the photographic coverage is shown in Figures 2 and 3. These photographs show that the area has little indication of sub-regolith structural details or bedrock and few distinct geologic boundaries. A broad northwest-trending arrangement of the major topographic features parallels other elements which are radial to the Imbrium basin.

#### Geology

The geology of this region has been mapped at a scale of 1:1,000,000<sup>(1)</sup>. Three geologic units have been recognized at this scale. The rugged terra unit is characterized by rugged terra topography lacking dominant regular patterns. The terrain is typically steep sloped with hills and valleys a few kilometers in width. Milton<sup>(1)</sup> has interpreted this unit as consisting of a volcanic mantle of varying thickness probably concealing material ejected from the Imbrium basin, but still reflecting the subjacent structure in topographic form. A second unit mapped in this area is characterized by northwest-southeast trending rolling plains and

shallow depressions. These features are typical of the "Imbrium sculpture" radially and subradially surrounding the Imbrium basin. They may owe their origin to faulting, fracturing, or deposition coincident with the origin of the Imbrium basin or they may represent areas reactivated during subsequent volcanism. The third unit is a facies of the Cayley Formation and is characterized by low hills, craters, and irregular depressions marginal to intermediate albedo materials of the level plains, which are more characteristic of the Cayley Formation. This facies of the Cayley may represent areas where a cover of presumed volcanic origin is thinner or where constructional volcanic features are present.

The units mapped in this area are typical of areas in the highlands surrounding the Imbrium basin. They probably reflect a history dominated by the origin of the Imbrium basin and deposition of the Fra Mauro Formation in the form of a gigantic ejecta blanket. A combination of deposition and fracturing at the time of this event produced the characteristic linear structures associated with the basin. Subsequent volcanism perhaps related to the Imbrium event but certainly following closely behind it appears to have deposited material in low-lying areas (Cayley Formation) and may also have thinly blanketed positive features. Volcanic activity in this area appears to have been confined to the Imbrian Period (i.e., post-dating the origin of the Imbrium basin) but also appears to have occurred prior to the deposition of the majority of surface mare material. Subsequent cratering and regolith formation generally obscures detailed relations between geologic units.

The Lade Area (III-S-10) bears some resemblance to several other Apollo sites. Material similar to the Imbrian ejecta mapped at the Fra Mauro site may be exposed in this area. Also, some of the Cayley facies seen here may be similar to those mapped at Descartes and Hipparchus.

Since extensive outcrop and discrete geologic boundaries are lacking at this site, a broadly "representative" sampling of typical terra is probably the most logical scientific objective. Several large fresh blocky rimmed craters exist in the high resolution frames, and a mission to the large fresh crater in the northern quarter of Lunar Orbiter III Frame H-81 (Figure 4) should at least indicate the depth to and nature of the bedrock material. Other features of interest in this region include several well-developed varieties of patterned ground<sup>(2)</sup>.

Another possible landing site (Figure 5) is located in Cayley type material in the northern part of L.O. III Frame H-80. This landing point should be close enough to the ridges so that samples of this material could be gathered.

The lack of discrete geologic boundaries at this site lessens the understanding of the history and significance of this area and places it in a low scientific priority in terms of a mission assignment for one of the remaining Apollo missions. Exclusion of several other highland sites from consideration for landing missions and more detailed study of the Lade geology are two factors which might raise the priority of a landing mission to Lade.

### Analyses

The Mapping Sciences Branch of MSC has carried out an evaluation of targets at the III-S-10 site for possible lunar exploration missions<sup>(3)</sup>. Data from these analyses are summarized in Table 1 and the location of the targets is shown in Figure 2.



J. W. Head

2015-JWH-kmj

### Attachments

References

Table 1

Figures 1-5



### References

1. Geologic Map of the Theophilus Quadrangle of the Moon, D. J. Milton, 1968, U.S. Geological Survey, Geologic Atlas of the Moon, I-546.
2. D. J. Milton, Personal Communication, June 18, 1970.
3. Evaluation of Landing Targets for Lunar Exploration; Lunar Orbiter Sites III-S-10 and III-S-15, Mapping Sciences Branch, Manned Spacecraft Center, May 1, 1968.

SITE	AREA OF SCIENTIFIC INTEREST	SELENOGRAPHIC COORDINATES OF TARGET CENTER	MAP BASE USED	PHOTO COVERAGE USED	SCALE OF PHOTOGRAPHS	TILT OF CAMERA	AVERAGE SUN ELEVATION	PERCENTAGE REJECT	UNWEIGHTED "N" VALUE
III S-10	TARGET NO. 1	1°18'S 13°31'E	AIC 78A DELAMBRE 1:500,000	LO III MR 80-83 HR 81	MR 1:79,147 HR 10,354	4.6°	22.8°	76.5%	0.235
III S-10	TARGET NO. 2	1°43'S 13°24'E	AIC 78A DELAMBRE 1:500,000	LO III MR 80-83 HR 81	MR 1:79:147 HR 10,354	4.6°	22.8°	79.5%	0.205
III S-10	TARGET NO. 3	(FIGURE 2)	AIC 78A DELAMBRE 1:500,000	LO III MR 80-83 HR 80	MR 1:79,147 HR 10,354	4.6°	22.8°	※	※

※ THIS LANDING TARGET WAS REJECTED BY MSC (3) WITHOUT FURTHER ANALYSIS PRIMARILY BECAUSE THE TARGET IS LOCATED TO THE WEST OF A PROMINENT RANGE THAT IS A POTENTIAL LM LANDING APPROACH RADAR HAZARD.

TABLE 1. SITE EVALUATION SUMMARY (3)

- 1 LADE
- 2 DESCARTES
- 3 TYCHO
- 4 CENSORINUS
- 5 ALPHONSUS
- 6 HIPPARCHUS
- 7 DAVY

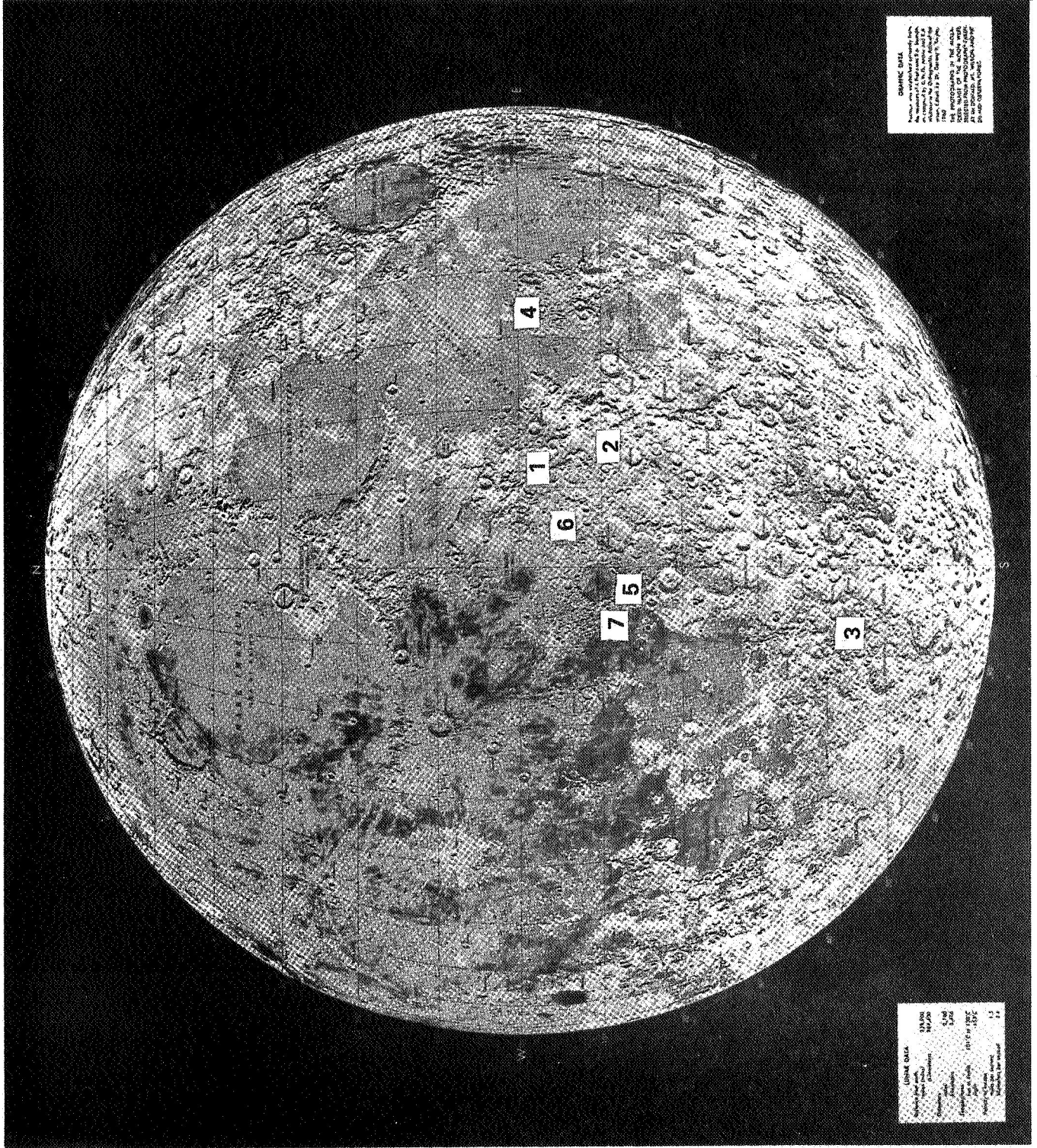


FIGURE 1



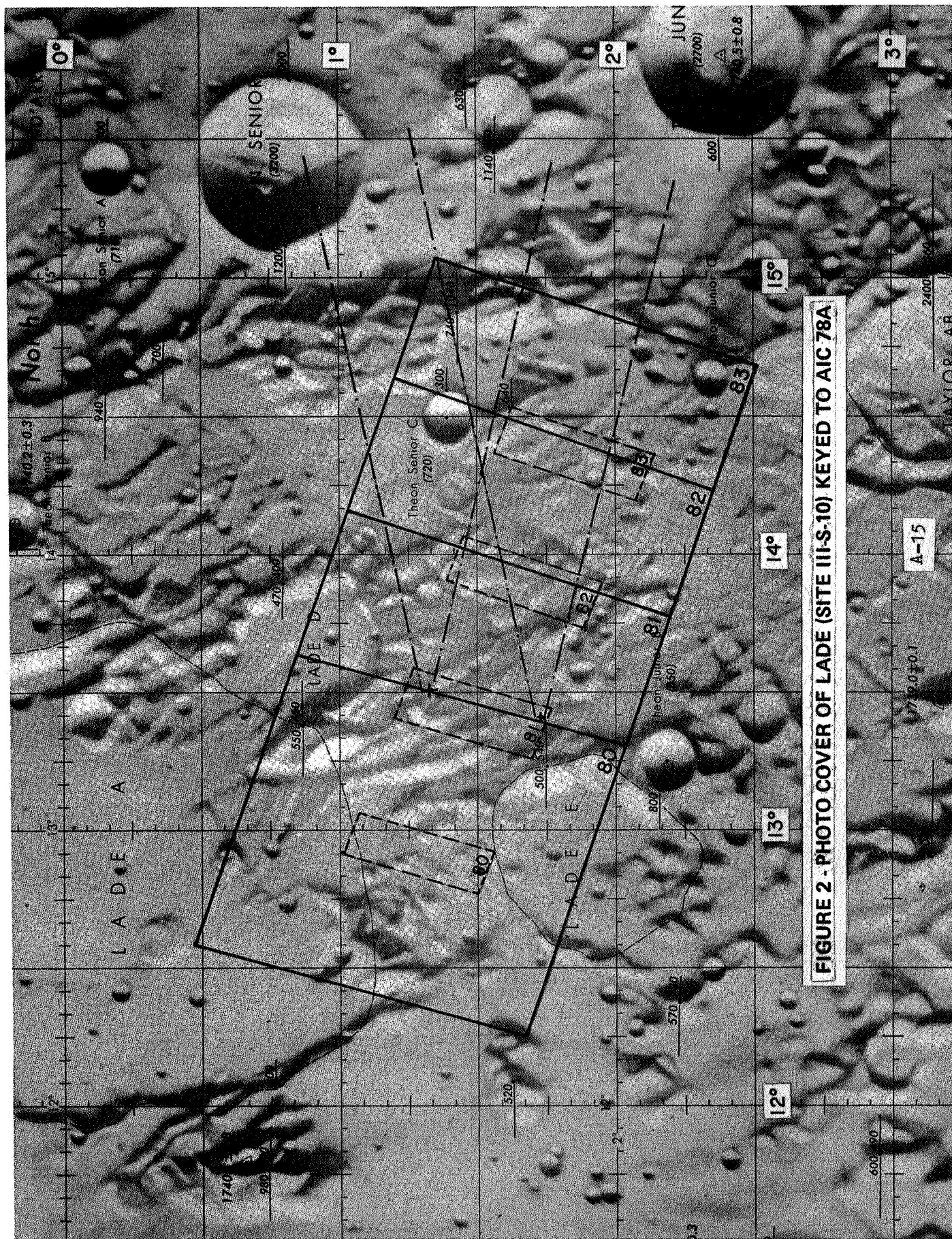
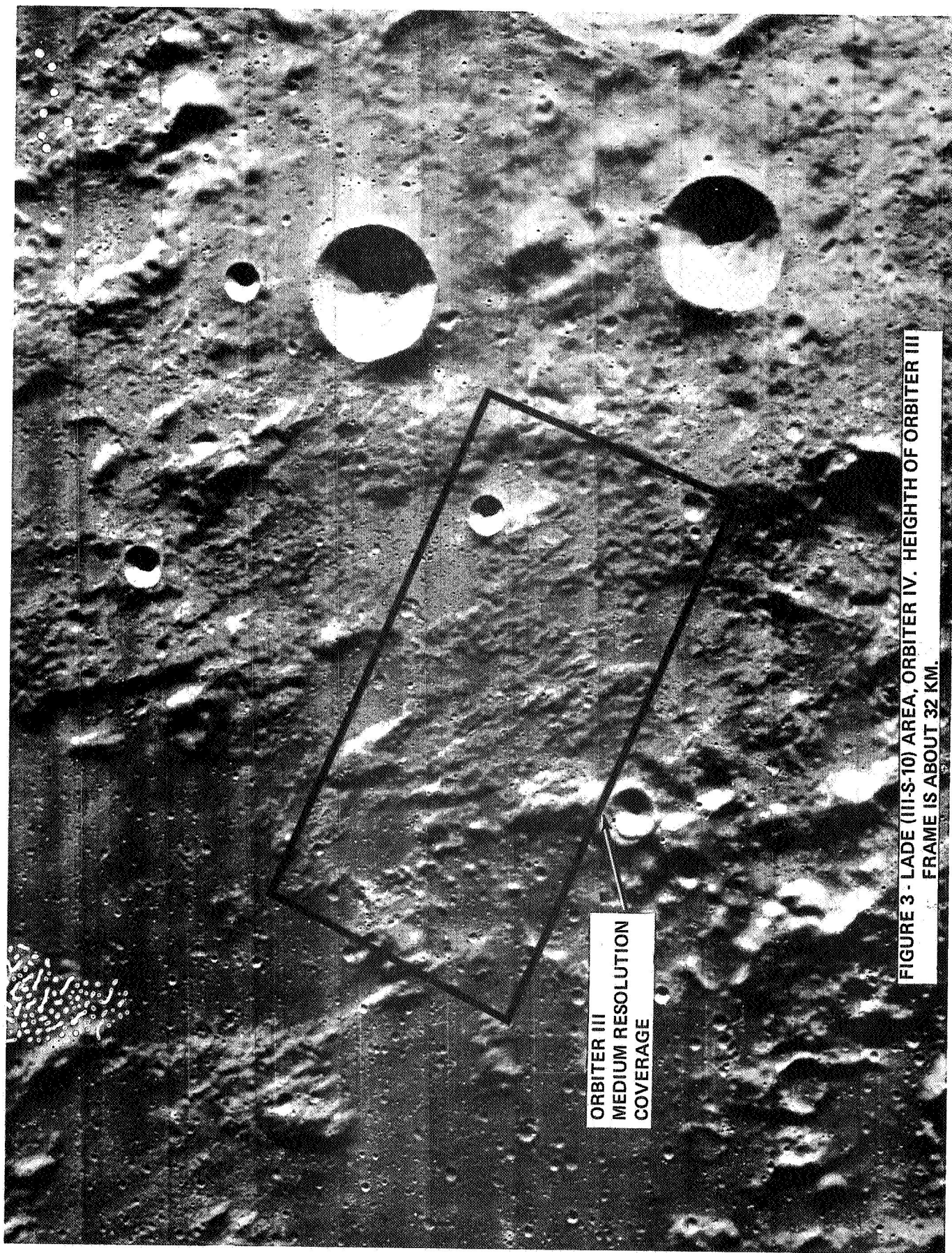


FIGURE 2 - PHOTO COVER OF LADE (SITE III-S-10) KEYED TO AIC 78A





ORBITER III  
MEDIUM RESOLUTION  
COVERAGE

FIGURE 3 - LADE (III-S-10) AREA, ORBITER IV. HEIGHT OF ORBITER III  
FRAME IS ABOUT 32 KM.



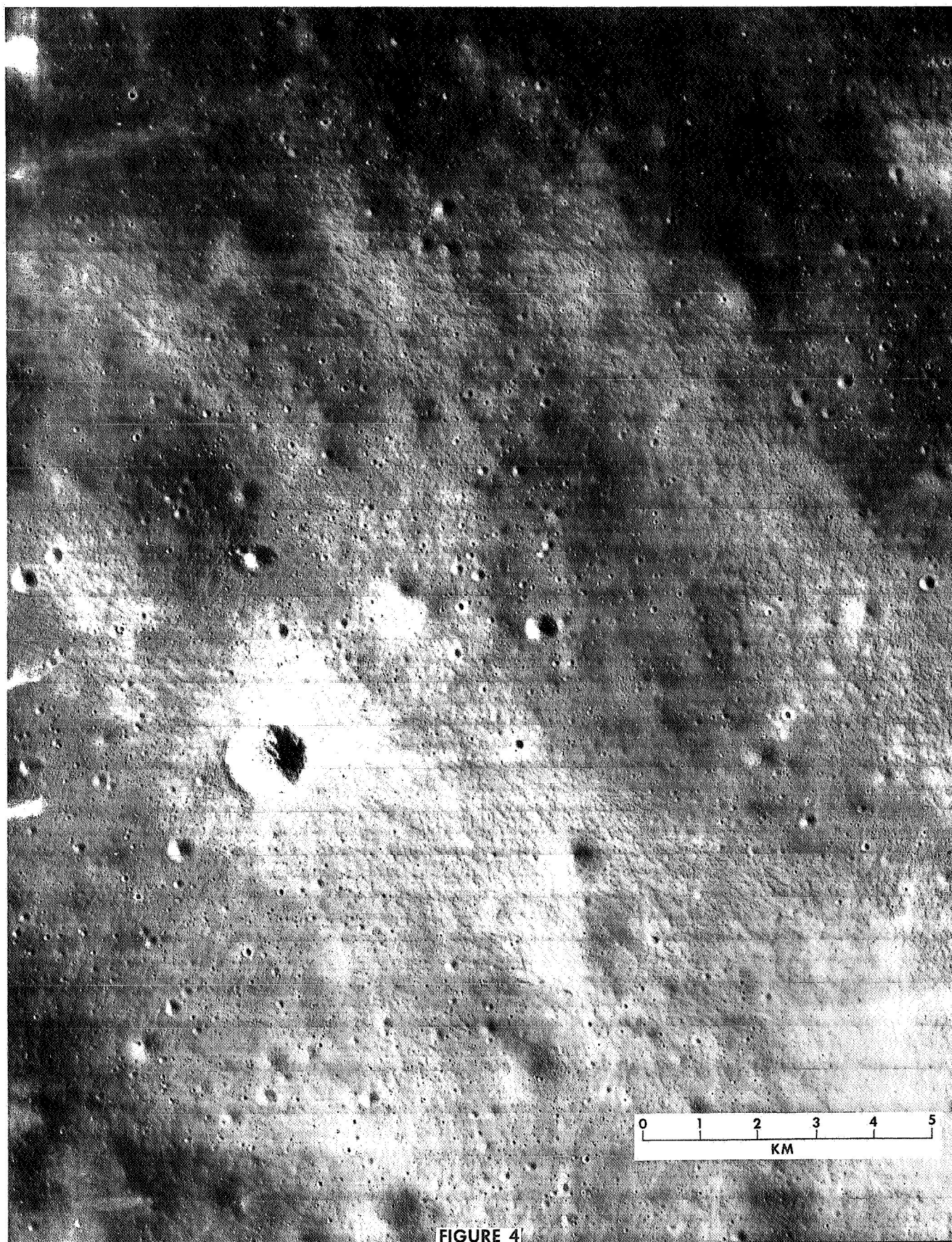


FIGURE 4



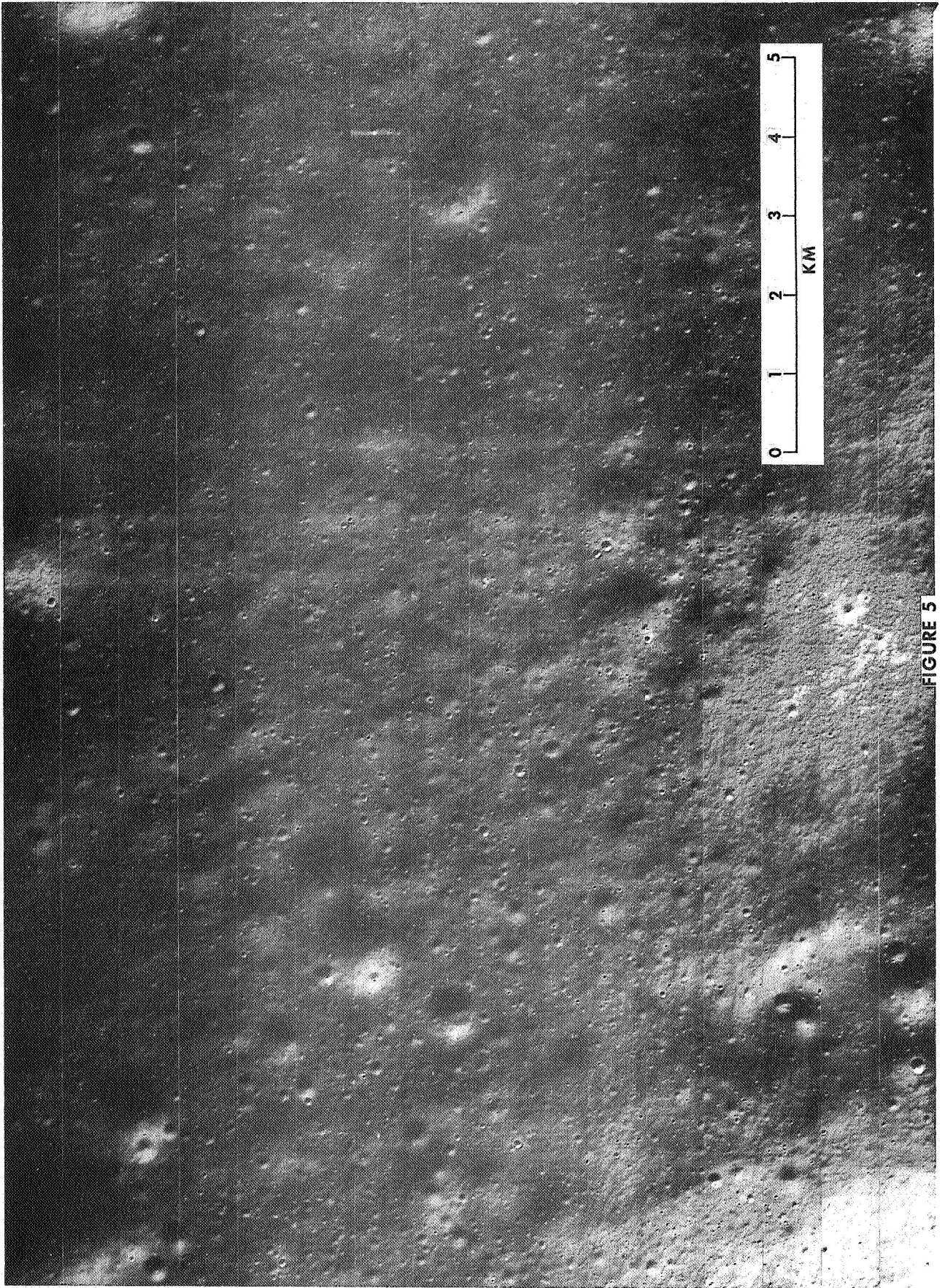


FIGURE 5

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